College of Engineering
UNIVERSITY OF WISCONSIN–MADISON

SPRING 2023 NEWSLETTER

CIVIL AND ENVIRONMENTAL ENGINEERING

A UNIQUE ENVIRONMENT

Preparing the next generation of civil and environmental engineers

Greetings from beautiful Madison!

I am glad to share that the Department of Civil and Environmental Engineering is stronger than ever. We're attracting some of UW's best students and producing exceptional engineers who are highly sought by the industry. Badger engineers are in demand! In addition, enrollment is on the rise, our curricula continue to diversify, and our research program is vibrant.

We recently won our sixth engineering education award from the National Council of Examiners for Engineering and Surveying, a recognition for which we are tremendously proud. The award stems from work completed by students in our capstone course that will help realize a new lakefront park in Monona. Our capstone experience is all about real-world engineering and is truly world class, thanks in large part to our dedicated Professors of Practice team. This outstanding group of experienced engineering practitioners partners with our faculty to enhance and broaden our students' learning experience in their transition toward professional practice. I am thankful for their contributions and inspired by their service.

The growth in our department reflects a broader demand for engineers to help solve the current and future grand challenges we face as a society. Expanding the engineering campus is a top priority for UW-Madison and a new, state-of-the-art engineering building is a critical to provide the level of education our students need to lead successful, rewarding careers. Philanthropic support from alumni and friends like you are essential to make the new building possible. Visit engineeringthefuture.wisc.edu to learn more about the future of engineering at UW-Madison and how you can help.

I hope you enjoy reading about the latest news and accomplishments of our community in this issue. As always, please feel free to come by whenever you are in Madison to meet our students, faculty and staff, and see firsthand all the great things we are doing.

On, Wisconsin!

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Get ready to golf!

Attend our 26th annual golf outing on Friday, Sep. 29, 2023, for a day of fun and fundraising with other alumni, industry colleagues, faculty, staff, and students. Your support helps elevate our students' educational experiences and better prepare them for their careers. Watch your email for an invitation to register or check golf.cee.wisc.edu.

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Students conduct experiments in CEE's *Environmental Engineering Mechanics* class. The class, taught by Mohoan Qin, is a new, integral part of our environmental engineering program.

One-of-a-kind environmental engineering class overflows with real-world examples

Mohan Qin

A new course in environmental engineering is teaching students how the materials they use in civil infrastructure can have broad, lasting impacts on the world around us.

Assistant Professor Mohan Qin is teaching CEE 325, the environmental engineering materials course. The course includes two lectures and one lab session per week, all focused on teaching students how the building blocks of civil infrastructure interact with water and air.

Throughout the course, students learn how different materials behave and react to certain conditions, and how to conduct tests and interpret results to understand how those materials are performing. They also learn how to conduct forensic studies to determine how material properties may play a role in the event of a treatment or conveyance system's failure.

Qin says this knowledge may be useful for typical purposes—for example, determining what types of pipes are best for regions with hard water, like swathes of the Midwest. It can also have huge implications for the health of entire communities, such as in the water crisis in Flint, Michigan.

"Initially, when we design a system and put pipes down, we expect that the material can be stable or work safely for several decades," Qin says. "But if the water or soil are too corrosive, it can wear that material down and cause corrosion and contamination, which will be a big focus of our course."

Students also learn how factors like density and porosity, thermal expansion and contraction, and microbial growth will impact the materials they select for environmental infrastructure.

This environmental engineering materials course launched in fall 2022, with more than 20 students, as a permanent piece of the College of Engineering's BS in environmental engineering program. As the environmental engineering bachelor's degree program grows, Qin expects that 70 to 80 students will take the course each year.

Aubrey Barthel is a sophomore environmental engineering student in Qin's class for the spring 2023 semester. She wants to go into wastewater management or environmental remediation, and says the class is providing important knowledge for future engineers to know how to use the best materials for their work.

Barthel chose the environmental engineering program for its hands-on experiences, and says Qin's materials class gives students a chance to see how what they've learned impacts the world around them. "It's all applicable," she says. "Everything we've learned in chemistry or physics before coming into this class, we get to apply to real-world situations, which has been really nice to see."

A course in environmental engineering materials is unique to UW-Madison. Qin and Professor Greg Harrington, the CEE undergraduate program chair, say the course is, to their knowledge, the only one of its type in the United States. Qin says they hope to encourage other programs to add similar education.

"This is the type of course that I think will be very beneficial for students," Qin says. "Greg and I will be talking about this course at a conference in the summer. We plan to tell our colleagues in the field about this course, to get feedback from them and to encourage others to have this sort of course in their programs."

Shining light on the sun's role in lake carbon cycling

Graduate student Reid Milstead is working with Associate Professor Christy Remucal to study how sunlight affects the carbon cycle in northern lakes.

Christy Remucal

Lakes are home to reservoirs of organic matter that may ultimately move into the soil or the atmosphere.

Associate Professor Christy Remucal seeks to understand how sunlight plays into this process, which is called the carbon cycle.

The carbon cycle lays out how carbon in the atmosphere, soil or water moves among those different reservoirs. Maintaining the right balance is key to the future of our climate. Too little carbon dioxide in the atmosphere and our planet freezes; too much and we roast.

In lakes, says Remucal, dissolved organic matter is a "soup" of organic chemicals introduced through nearby plants or bacteria that live in the water. Sometimes this matter is visible in satellite images as splotches of murky brown, where inland water flows into the ocean.

"If you've ever seen, in wetlands, that tea-colored stuff in the water, that's organic matter," she says. "It's important for carbon cycling because it's made up of organic carbon and if it gets mineralized, it makes carbon dioxide, which is a greenhouse gas."

Remucal's research group is using advanced mass spectrometry techniques to understand what happens when sunlight interacts with organic matter in lakes. The researchers are studying waters that are part of the National Science Foundation's North Temperate Lakes Long Term Ecological Research Program (LTER). Organic matter can vary from lake to lake—Lake Mendota's will be different from what's found in a bog in northern Wisconsin, for example—so working with the LTER program allows Remucal's group to compare samples from well-studied aquatic systems from across the state.

A lot of research has focused on bacteria's role in creating carbon dioxide in lakes. They consume the dissolved organic matter in water and produce carbon dioxide as a byproduct, in the same way we produce carbon dioxide through respiration. Remucal's photochemistry research looks at the phenomenon from a new angle.

"Lake models don't really consider sunlight at all," she says. "We're looking at that process, which has been understudied and neglected, but we think could be really important in some lakes."

Carbon dioxide is the most prevalent greenhouse gas on earth, and studying how it proliferates through natural processes will help us understand the factors that contribute to our changing climate. "Because lakes are so influential in how much carbon dioxide gets released into the atmosphere, it's very important to understand how this process happens," Remucal says. "This can help make better forecasts for carbon behavior, which is really important for our understanding of climate change."

Understanding the hidden stressors in geothermal plant operations

Geothermal plants can change the earth around them, and not just while they're active.

Such plants draw on heat in fractured underground reservoirs. They pump up heated water, which can be used for power generation, and replace it with cooler water that is, in turn, warmed by the natural forces within the earth.

But when the plants shut down, the pressures they introduce into surrounding rocks change. UW-Madison geological engineers are seeking to understand how that change in pressure and stress affects subsurface fluid flow.

Kurt Feigl, a professor of geological engineering and geoscience, is leading the effort to collect measurements from a geothermal field in San Emidio Valley in northwest Nevada. The U.S. Department of Energy is funding the project.

Sabrina Bradshaw, a GLE researcher and assistant project manager, says the plants reduce the amount of pressure in underground reservoirs when they're pumping water out for energy production. When a geothermal plant

Senior design 'upcycles' historic lake property

The National Council of Examiners of Engineering and Surveying awarded the department its Engineering Education Award for a project in the senior capstone design course. A student team crafted plans to redevelop San Damiano Park, which was originally built as a residential home on Lake Monona in Madison.

In November 2022, we received the Engineering Education Award from the National Council of Examiners for Engineering and Surveying. The award honors the work of senior engineering students enrolled in our capstone design course, which is required for all graduating CEE students. It brings together practicing engineers, educators, community clients and students to create thoughtful solutions for real-world engineering challenges. Clients open to helping students gain real-world civil engineering experience propose the projects, which often are interdisciplinary, open-ended and touch on a broad set of themes, including general building design, transportation design, and environmental design.

The award-winning project provides redevelopment plans for San Damiano Park, which occupies 10 acres on the southwest shore of Lake Monona in Madison. It was built as a residential home in the 1890s and later was used by several religious orders before the city of Monona bought the land in 2021. The city has since been discussing possible plans for the property. The students' project focused on historic preservation and ways to incorporate recreational uses for the community.

The city of Monona issued a request for proposal for our senior design students, who responded with formal engineering proposals. From there, the students crafted three alternative designs for the park's redevelopments. Each design included a new building for kayak and canoe rentals and storage, a refreshment stand, first aid station, restrooms, and parking area modifications with several new accessible spaces.

Students presented their ideas to a panel of judges composed of engineers, architects and members of the public. They, along with the city of Monona, ultimately selected the students' second alternative, which included a restaurant, event space, industrial kitchen, and two-story deck with a lake view.

With the second alternative design selected, students finalized the design plans through close collaboration with faculty, mentors and the city of Monona. Throughout the project, students were exposed to various open-ended problems, which developed their research skills and ability to work with incomplete information to move the project forward.

Fall 2021 CEE graduates Andrew Baker, Adam Wehking, Mason Bartol and Jacob Klenz worked on the project. CEE adjunct professors Jan Kucher and Mark Oleinik, as well as CEE Professor Greg Harrington, provided guidance to the students. Charlie Quagliana and the late Loei Badreddine were professional engineering mentors for the project, and CEE alumnus Ken Koscik and GLE alumna Alyssa Sellwood served as team judges.

"We are so proud of our students and capstone instruction team for their hard work and for this recognition," says Chair Bill Likos. "The capstone experience is a highlight of our curriculum and gives our students direct, hands-on experience working on real engineering projects. It's experiences like these that make Badger civil and environmental engineers the best in the field."

A CEE research team deployed a field of seismographs around a geothermal planet in Nevada to monitor for shifts in the earth when the plant shut down.

shuts down production, water slowly fills back into the reservoir, which increases pressure on the rock throughout the geothermal field. That change in pressure could induce small vibrations in the earth's crust that can only be detected with sensitive equipment.

Feigl's research team deployed a network of 450 densely placed seismographs around an industry partner's geothermal plant in the San Emidio Valley. The seismographs, which are about the size of a coffee can or small potted plant, remained in place for a month to measure tiny vibrations. The researchers also are monitoring movement in the earth's crust by comparing successive satellite images. They'll create four-dimensional models of the earth's crust around the plant by identifying when and where microseismic events happened.

"We're studying crustal deformation around this geothermal plant," says CEE graduate student Anya Wolterman. "We're looking at how the plant's operations, which alternate between normal pumping and shutting down for maintenance, affect the underlying fault."

Feigl says he hopes the project will increase understanding of how geothermal plants impact their surroundings. If researchers can create models to accurately predict how a plant will change the underground stresses in a geothermal field, they can work with geothermal industry partners to optimize plant operation and minimize their environmental impact.

EWB brings hands-on design experience with Ugandan project

After a long wait, the student chapter of Engineers Without Borders finally are working with community members on the other side of the world to construct two schoolhouses in rural Uganda.

The Uganda group has designed two schoolhouses for Bunangwe Buyobo, a rural community in eastern Uganda. Anna Janicek, a senior studying materials science and engineering and a project manager for the Uganda team, says the students are partnering with the Good Shepherd Community Development Association to see the project through. The project has been in the works since 2019, and after several delays due to the COVID-19 pandemic, construction finally began in January 2023.

"Right now, the community has a school," Janicek says. "It's a wooden structure with a sheet metal roof. In the past, they've had problems with termites and the roof has blown off. So we want to help them build a more complete, secure structure that's completely enclosed."

Estimates for the schools came in at about $135,000—much higher than expected due to increased material costs. Though the team had to make some tough decisions and scale down the project's scope, Janicek says the students are committed to seeing both schoolhouses built.

"We don't want to just build one schoolhouse and leave the community hanging for three years before we get enough money for the next one," Janicek says.

In fact, for the fall 2022 semester, the team pivoted its primary focus to raising funds. Those efforts brought them to Virent, a Madison-based biofuels company with origins in the lab of James Dumesic, a chemical and biological engineering professor emeritus. Virent is supporting the EWB Uganda project with a $10,000 donation.

"Providing opportunities for future engineers to understand and apply their skills in a manner that will make a difference in the world can be rewarding for both the community and those students involved," says Virent pilot plant engineer and Engineers Without Borders-Madison area professional chapter co-president David Appleby. "We are very pleased at Virent to support the Uganda project and the UW engineering students that have worked hard to make it a reality."

Janicek calls the donation a huge help—one that enabled construction to begin.

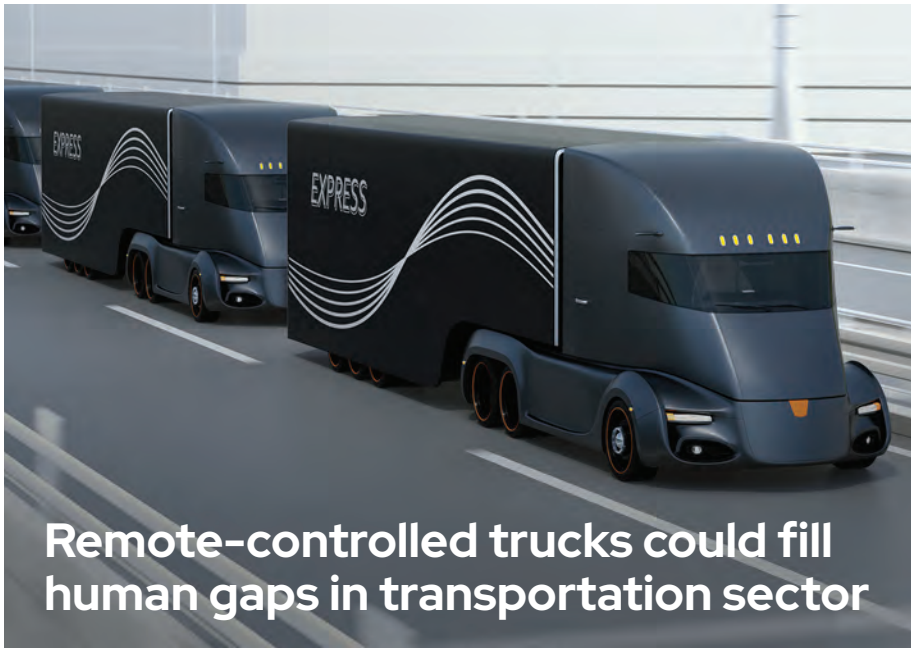
"There have been some frustrations along the way, knowing all the hard work the whole team has put into this project," she says. "But it's really rewarding to see the construction starting while I'm still here. I have been in contact with the community for so long, and it's exciting to finally get them this project that they've been looking forward to for years."

EWB is one of the largest student organizations at UW-Madison. It's open to undergraduate and graduate students, and members don't have to come from engineering or even have engineering-related experience.

The Ugandan project has been a lesson in perseverance—one Janicek will leave UW-Madison with, and one she'd share with the younger students who will follow in her footsteps.

"Be patient," she says. "It's better to have a good, solid design and to be sure everything is running smoothly than to rush and have a problem you can't fix because the project is being built on the other side of the world."

The Engineers Without Borders Uganda project team has worked for years to see a project through to completion. The team has raised enough money to begin construction on two schoolhouses for a rural Ugandan community.



Remote-controlled trucks could fill human gaps in transportation sector

You don't have to work in the transportation industry to feel the impact of America's trucker shortage.

Madhav Chitturi

Across the United States, the issue, which has simmered for years, reared its head as the nation's supply chain struggled to accommodate a nation settling into "normal" life after the worst of the COVID-19 pandemic.

Our Traffic Operations and Safety (TOPS) Lab researchers are looking at remote-controlled trucks as an option to help alleviate the pressure on the nation's trucking industry.

The American Trucking Association reported in October 2022 that the industry was 78,000 drivers short in 2022—only a few thousand drivers lower than a historically high 81,000 in 2021. If the current trends hold, the ATA says the shortage could more than double to 160,000 drivers by 2031.

Without enough drivers to move them around, goods pile up in shipyards and warehouses, lengthening wait times for products to get to store shelves. That strained supply drives up costs for consumers.

As the shortage draws increased attention, some have pointed to automated vehicles as potential relief valves for the shortage. Madhav Chitturi, a researcher with the TOPS Lab, says that though automated vehicles may one day prove to be the answer for the shortage, there's a lot of research work and testing still to be done to make that a realistic option.

"The industry is interested in automation," Chitturi says. "But we're still quite far away from full automation. It might be decades."

In the interim, remote-piloted trucks may provide an alternative. Conceptually, a remote-pilot system would work via operators in a centralized control hub who "drive" trucks across a region or the country. It's kind of like a life-sized video game.

To test remote piloting's feasibility, the research team is working with licensed truckers to participate in simulator experiments. In those experiments, the drivers operate simulated remote-controlled trucks, and researchers gather feedback on how well the trucks performed under that remote guidance. At the same time, other drivers control passenger cars in the same simulator environment.

"One of the ways we can tell if someone is driving distracted or under the influence is their behavior," Chitturi says. "If they're drifting all over the place, then we can tell that something is wrong. If these drivers who represent passenger cars on the road can't tell that something is different about the trucks, then that's a success to us."

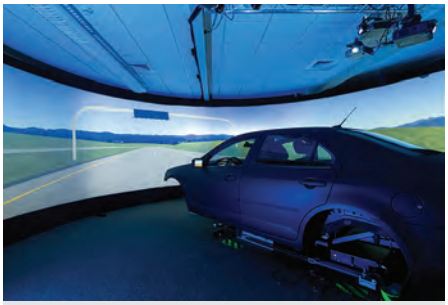
Chitturi says a remote hub for piloting trucks could, conceivably, improve the work lives of America's truckers by addressing some of the job's biggest challenges: long hours on the road, and being away from loved ones for potentially weeks at a time. Opening the work to an additional type of job may attract groups of people who aren't currently represented in the trucking industry.

However, Chitturi says there are challenges. One of the biggest is determining what happens if the signal between the central hub and the truck goes out, or experiences latency. "What happens if you're out in the middle of nowhere with poor signals? That's a question we have to assess if this is going to be seriously looked at," he says. "Is there a way to keep the vehicle operating safely? We have to be sure the onboard automation can bring the vehicle to a safe state."

There are also human elements to figure out—for example, whether the control stations are simple computers with screens, or if they're more immersive, set up like a truck cabin, with a steering wheel front and center.

UW-Madison researchers are collaborating with economist Brad Hershbein from the W.E. Upjohn Institute for Employment Research and Steve Viscelli of Freight Research Inc. They'll help answer questions like how a shift to remote piloting might impact training new operators or retraining existing truckers for remote work. They'll look at how that change could affect areas where truckers currently live and work.

"This isn't something that one discipline can solve," Chitturi says. "You might have the technology for something, but that's just a means to an end. We need to consider societal impacts, and that's where we bring in this multidisciplinary expertise. This could be great for technology, but is it worth it if it decimates rural areas because those jobs are suddenly gone? While this can help solve a problem, we want to be sure it does not create other problems."



College of Engineering researchers will use our full-scale simulator to determine the feasibility of using remote systems to control semi trucks. Remote-controlled trucks may help alleviate a worsening labor shortage in the trucking industry.

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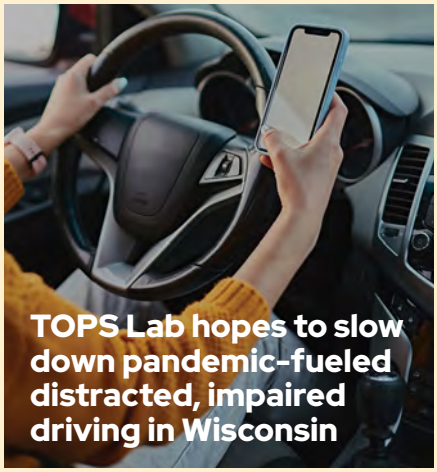

TOPS Lab hopes to slow down pandemic-fueled distracted, impaired driving in Wisconsin

Traffic plunged across the United States at the onset of the COVID-19 pandemic in spring 2020.

Wisconsin's traffic followed this trend, too, plummeting along with total crashes. Paradoxically, even with fewer drivers on the road, vehicle fatalities rose.

The problem isn't limited to Wisconsin. In September 2022, the National Highway Traffic Safety Administration pleaded with motorists to be careful while sharing "devastating" preliminary traffic fatality figures from the first quarter of 2022. Nationwide, more than 9,500 people died in crashes — 7% higher than the same period in 2021.

Now, researchers at the TOPS Lab hope to gain insight into the behaviors fueling this trend through a new study to clarify the prevalence of distracted or impaired driving in crashes on Wisconsin's roads.

The work will allow officials and traffic engineers to employ a "Safe System" approach to addressing those behaviors, including educational outreach programs, improvements in road design, or adjusting how vehicles interact with drivers and their devices.

While there is readily available data for impaired driving, it can be hard to quantify the role distractions—whatever form they may take—play in causing serious crashes.

"The idea of distracted driving isn't new, whether it's thinking about what you have to do for the day, or kids making noise in the back seat or looking at your cell phone," says Andrea (Andi) Bill, associate director of the TOPS Lab. "It's a very difficult problem to understand, but until we know what types of distraction are causing these crashes and where they're occurring, we can't know how to solve it."

Bill says the TOPS Lab team wants to determine whether impaired or distracted driving is under- or overreported in Wisconsin. If officials have good, accurate data to lean on, then the state can take steps to reverse the trend of rising deaths and eliminate preventable traffic fatalities.

"Our mission at the TOPS Lab is to make Wisconsin's roads safer," Bill says. "With COVID, we saw impaired driving go up. We saw distracted driving go up. We saw those types of risky behaviors increase, and this will help us get a better understanding of how we can address those increases in fatal crashes."

The TOPS Lab will collaborate with the Wisconsin State Laboratory of Hygiene, which conducts toxicology testing, and will draw on hospital data and other datasets housed on the WisTransPortal System. The lab will also work with engineering firm VHB and with Xiao Qin, a professor of civil and environmental engineering at the University of Wisconsin-Milwaukee. The National Academies of Science, Engineering, and Medicine is funding the project through a three-year, $450,000 grant.